INDIA WEATHER REVIEW, 1959

ANNUAL SUMMARY

PART C

S T O R M S A N D D E P R E S S I O N S

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INDIA WEATHER REVIEW, 1959

ANNUAL SUMMARY

PART-C

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STORMS & DEPRESSIONS

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I. DEPRESSIONS AND CYCLONIC STORMS

During the year, 2 cyclonic storms and 6 depressions formed in the Bay of Bengal and 4 cyclonic storms and 2 depressions formed in the Arabian Sea. There were also 2 land depressions during the year. The dates of activities of the storms and the greatest barometric depths observed (or estimated) near their centres are given in the following table.

Locality	Month	Date	Greatest observed barometric depth
Arabian Sea	May	19th-24th	45 mb (observed)
	June	25th-30th	30 mb (estimated)
	July	15th-19th	18 mb (estimated)
	October	10th-18th	37 mb (observed)
Bay of Bengal	June	27th-29th	18 mb (estimated)
	September	27th-30th	30 mb (estimated)

The detailed descriptions of the storms and depressions are, as usual, followed by a list of western disturbances of the year, the more important local storms and of the locations in which wind force of 9 B.F. or more unconnected with cyclonic storms were experienced by ships in the Indian Seas.

1. Severe cyclonic storm in the Arabian Sea - 19th to 24th May

A temporary advance of the monsoon into the Arabian Sea south of Lat. 8°N took place by the morning of 17th. Widespread rain with locally heavy falls occurred along Malabar coast and Arabian Sea Islands. The monsoon advanced further into Laccadives area and along Malabar coast during the next 48 hours. A low pressure area appeared in the southeast Arabian Sea near Laccadives on the 17th May and became more marked the next day. At 0530 hrs IST of 18th, Ship Hathi (Lat. 12.2°N and Long. 74.6°E) reported a southeasterly squally wind of speed 35 knots with present weather violent rain showers. During the next 24 hours, the cyclonic circulation extended upto 5 kms above sea level and the upper winds in the whole of southern and western Peninsula came into the grip of a circulation.

The low concentrated into a depression on 19th morning with centre at 0830 hrs IST near Lat. 10.0°N and Long. 71.0°E. S.S.Carthage off Karwar reported southeasterly wind of 25 knots. The depression moved northwestwards and was centred at 1730 hrs IST near Lat. 11.0°N and Long. 70.5°E. At this time, winds of speed 20 to 30 knots were reported from the depression field suggesting that the depression had become deep. At 0830 hrs IST of 20th, the deep depression was centred near Lat. 12.5°N and Long. 69.0°E.

S.S. State of Bombay, which was moving in a northeasterly direction and approaching the centre of the disturbance, reported northwesterly 25 knots and a wave height of 3 metres and heavy continuous rain at 0530 hrs. IST, when it was about 150 kms due west of the centre of the depression. It reported northwesterly 34 knots, wave height 3.5 metres and heavy continuous rain at 1730 hrs IST when it was 80 kms west of the centre. These observations showed that during the course of the day, the deep depression had intensified into a cyclonic storm centred at 1730 hrs IST of 20th near Lat. 13.0°N and Long. 68.5°E. The observations from S.S. State of Bombay are given below :

OBSERVATIONS FROM S.S. STATE OF BOMBAY

Date and Time IST	Position		Wind		Weather		PPP	Wave		
	Lat. N	Long. E	Direction	Vel. kts.	Present	Past	Corr. mbs.	Direction	Period	Height metres
19/5 2330	11.8	67.4	320	24	Overcast	Overcast	1002.3	310	5	3.3
20/5 0530	12.5	67.7	315	24	Squalls heavy continuous rain	Squalls showers	992.0	315	5	2.7
0830	12.8	67.3	023	28	Overcast moderate continuous drizzle	Overcast rain	997.0	023	5	3.0
1730	13.5	67.9	338	34	Overcast heavy continuous rain	Overcast rain	991.7	338	9	3.3
2330	14.0	68.3	060	30	Overcast slight drizzle	Overcast drizzle	994.7	050	7	3.9
21/5 0530	14.7	68.9	100	22	Cloudy	Cloudy	997.6	100	7	3.0

After the midnight of 20th, the cyclonic storm took a more westnorthwesterly course and was centred at 0530 hrs IST of 21st within a degree of Lat. 13.5°N and Long. 67.5°E. The first signs of further intensification into a severe cyclonic storm became available when S.S. Amra (Lat. 13°N Long. 65°E) reported a northnorthwesterly wind of 44 kts at 0930 hrs IST and 52 knots at 1130 hrs IST of 21st. High seas were reported in both the observations. By this time, the cyclonic storm had become severe and the centre could be fixed near Lat. 14.0°N and Long. 65.5°E. The two hourly observations recorded by the ship during 21-22nd May 1959 are given below :

OBSERVATIONS FROM S.S. AMRA

Date and Time IST	Position Lat. N	Position Long. E	Wind Direction	Wind Vel. kts	Weather Present	Weather Past	PPP Corrected	Wave Direction	Wave Period Sec.	Wave Height metres
21/5 0615	13.2	65.3	N to NW	27	Violent thunderstorm	Lightning to NE	993.7			2.4 to 2.7
0730	13.0	65.0	340	30	Thunderstorm	Thunderstorm	994.3	330	5 or less	2.5
0930	13.0	65.0	330	44	Overcast Intermittent rain.	Heavy rain	995.4	320	- do -	
1130	12.1	64.1	300	52	Overcast heavy rain	- do -	995.7	290	-do-	8
1330	12.1	64.1	280	52	-do-	-do-	994.2	280	6-7	8.5
1530	12.0	64.1	270	44	-do-	-do-	994.6	270	6-7	8.5
1730	11.1	64.1	260	46	-do-	-do-	995.3	260	6-7	7
1930	11.1	64.1	260	47	-do-	-do-	995.7	260	6-7	8
2130	11.0	64.1	270	44	Overcast	Heavy rain	998.5	027	6-7	4.5
2330	10.1	63.1	290	30	Heavy rain in sight	Overcast	1000.2	029	5	4
22/5 0130	10.1	63.1	260	30	-do-	-do-	995.3	026	5	4
0330	10.1	63.0	260	30	-do-	-do-	999.1	026	5	4
0530	10.0	62.1	250	33	Squalls in sight	Cloudy	998.4	025	5	4

During the next 24 hours or more, there were no ship observations within two degress of the storm centre. Hence the position of the centre could be fixed only approximately. At 1730 hrs IST of 21st, the severe cyclonic storm was centred near Lat. 14.0°N and Long. 65.0°E. The ships observations received on this day showed that the winds in the southern sector even far away from the centre were stronger than those in the other sectors at comparable distance from the centre. They were of the order of 40 - 50 knots in the southern sector even at a distance of 300 kms from the centre. On 22nd, the severe storm was centred near Lat. 14.5°N and Long. 63.0°E at 0830 hrs IST and moving west-northwest, it was centred near Lat. 15.5°N and Long. 60.5°E at 1730 hrs IST on the same day.

On the 22nd, S.S. Malika which was bound for Bombay came into the storm field. At 1130 hrs IST, the ship (Lat. 15.5°N and Long. 59.5°E) reported a northwesterly wind of 30 kts and pressure 995.7 mb. By 2030 hrs IST, when the ship was at Lat. 14°9'N and Long. 59°5'E, the wind had increased to 60 knots from the west and pressure had fallen to 980.0 mb (a drop of 15 mb in 9 hours).

At this time, the ship was probably closest to the centre of the storm which could be fixed near Lat. 15.5°N and Long. 59.5°E. Between 2030 and 2330 hrs IST, there was a marked shift in the wind direction reported by the ship. The wind backed west to southwest and the pressure rose by 6.6 mb. At this stage, the severe storm had apparently developed a core of hurricane winds which extended to about 100 km from the centre. Details of observations recorded by S.S. Malika lying in the storm field are given below.

OBSERVATIONS FROM S.S. MALIKA

Date and Time IST	Position Lat. N	Position Long. E	Wind Direction degrees	Wind Vel. Kts.	Weather Present	Weather Past	Pressure mbs.	Remarks
22/5 1130	15.5	59.5	320	30	Squalls Inter. heavy rain	Squalls	995.7	-
1800	14.8	59.4	270	11-12 B.F.	Blinding rain		983.7	Visibility very poor. Very rough sea. Heavy swell
2030	14.9	59.5	270	60	Heavy continuous rain	Rain	980.0	
2330	14.8	59.5	230	68	-do-	-do-	986.5	
23/5 1130	14.5	60.5	200	24	Slight rain	Rain	1001.7	

The severe storm continued to move in a westnorthwesterly direction. Its next position could be located with confidence at 1730 hrs IST of 23rd near Lat. 15.5°N and Long. 57.5°E with the observations of S.S. Socotra from 0930 hrs IST will 2130 hrs IST. Observations recorded by this ship are given below. It was unfortunate that at 1600 hrs IST, the ship's barometer was smashed, however her barograph recorded the lowest pressure of 968 mb half an hour later.

OBSERVATIONS FROM S.S. SOCOTRA ON 23.5.59.

IST	Position Lat. N	Position Long. E	Wind Dir. Deg.	Wind Vel. Kts.	Weather Present	Weather Past	PPP Corrected	Tendency Mbs.
0530	16.6	56.0	030	24	Slight rain	Overcast	995.4	-3.3
0930	16.3	56.5	010	30	Heavy rain	Rain	993.1	-1.1
1130	16.0	56.7	030	37	Heavy rain	Rain	991.0	-2.1
1330	15.7	56.9	350	44	-do-	-do-	983.8	-7.2
1730	15.2	57.3	290	60	-do-	-do-		Rising
1930	15.3	57.4	210	60	-do-	-do-		Rising
2130	15.3	58.1	170	44	-do-	-do-		Rising

Remarks

0930 Wind increasing and backing; intermittent rain.

1130 Wind still increasing, sea increasing; intermittent rain affecting visibility.

1330 Wind backing and increasing; sea rough; 1600 IST barometer smashed. Continuous rain.

1730 1630 barograph read 968 mb at lowest; wind force 11 backing, continuous rain.

1930 Wind steady at force 11, seas heap up; very rough; continuous rain.

2130 Wind backs 3 points; both wind and sea abating.

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As could be judged from the barogram of this ship, which recorded a lowest pressure of 968 mb at 1630 hrs IST and the observations of S.S. Oilfield which reported 963.5 mb at 2330 hrs IST, the depth of the severe storm was of the order -45 mb. Another interesting feature was the large radial inflow into the inner storm area from the west and northwest as would appear from some ships' observations at 1130 and 1730 hrs IST.

By 2330 hrs IST, S.S. Oilfield (16.4°N and 56.7°E), which was moving in a southwesterly direction, came close to the centre of the severe storm. At this time, it reported a northeasterly wind of 19 knots, while two hours earlier (i.e. at 2130 hrs IST) it reported wind northeast from 11, high seas and very heavy swell. Apparently the ship approaching the calm centre area by 2330 hrs IST and the centre was near Lat. 16.3°N and Long. 56.8°E. Extracts from the log of S.S. Oilfield are given below :-

OBSERVATIONS FROM S.S. OILFIELD
ON 23 MAY 1959

Time	Position		Wind		Weather	Pressure mbs	Bar. Tendency	Remarks
	Lat. N	Long. E	Dir. Deg.	Vel. Kts.				
1130	17.6	57.7	090	30	Squall	994.2	-2.8	-
1730	16.8	57.1	050	44	Squall	982.2	-4.0	2130 wind NE Force 11, High Sea. Very heavy swell.
2330	16.4	56.7	050	19	Moderate Drizzle	962.5	-2.0	-

From the pressure and bar tendency values, it would appear that between 1730 and 2030 hrs IST, there was a pressure fall of about 18 mb. With an average speed of the ship of 5-10 knots, it would roughly mean a gradient of 0.5 mb or more per mile.

The severe cyclonic storm continued to move in a northwesterly direction and crossed the Arabian coast near about Lat. 17°N by mid-day of 24 May, as could be judged from the observations from S.S. Bernice quoted below :

OBSERVATIONS FROM S.S. BERNICE
on 24th May 1959

Date and Time	Position Lat. N	Long. E	Wind Dir. Deg.	Vel. Kts.	Weather Present	Past	PPP Corrected mbs.	Pressure Tendency mbs.
0550	16.1	53.9	340	15	Heavy Cont.rain	Rain	988.7	-8.8
0830	16.4	54.7	270	60	-do-	-do-	977.6	-11.1
1130	16.5	55.2	200	58	-do-	-do-	984.0	6.4
1430	16.6	55.6	190	32	Moderate intermittent rain	-do-	990.8	6.8

From the numerous ship logs quoted above, it can be seen that the lowest pressure recorded near the centre of the severe cyclonic storm was about 963 mb and the maximum wind speeds were 60-70 kts (BF 11 to 12). Waves of height 8-9 metres and high seas were also reported. The average pressure gradient in the storm area was roughly 1 mb per 4 miles, reaching about 2 mb per 4 miles near the centre. The severe cyclonic storm had a core of hurricane winds and there was some evidence to suggest the existence of a calm centre also.

An interesting feature of the cyclonic storm was the damage caused at considerable distances by the swell produced by the storm. Commencing from the night of 20.5.59, reports were received of numerous small sailing vessels along the west coast of India running into serious difficulties. Rough seas breached the sea wall of Bombay on 25th May threatening to cut off road as well as telecommunications between the city and its suburbs. The storm at that time was about a thousand miles away from the Indian coast and was moving away. According to newspaper reports, the swell also caused inundation and partial destruction of many salt pans around Thana and Bassein creeks and at Bhaunagar on 22nd May 1959, 5,000 acres of lands in coastal parts of Broach and Surat districts were reported to have been rendered useless due to high tides following the storm.

Another feature was the heat wave that developed in Gujarat State, apparently caused by the initial flow of hot continental air from Rajasthan across Gujarat State into the outer circulation of the storm in the Arabian Sea. Very severe heat wave conditions prevailed in south Gujarat Region and coastal Saurashtra for 3 days. On the 20th afternoon Dwarka and Veraval recorded maximum temperatures of 43°C and 44°C respectively, which were their all time records. Broach recorded 47°C in the same afternoon. Cases of sun-stroke and death due to heat wave were reported from a few places in Gujarat State.

In association with the development of this cyclonic storm, a temporary advance of the monsoon took place in Arabian Sea south of Lat. 8°N by 17th May. It advanced further into Laccadives and along south Malabar coast during the next 2 days. With the movement of the storm in a westnorthwesterly direction, the monsoon activity weakened in southeast Arabian Sea and was confined to south of Lat. 8°N by 24th. Fairly widespread rain or thundershowers with locally heavy falls were reported on most days in the Arabian Sea Islands, and Kerala during the period 17th to 21st. Rainfall also extended along the west coast upto north Konkan. The chief amounts of rainfall recorded are given below :

Date	Station	Rainfall (cms)
17th	Trivandrum	7.5
	Minicoy	7.3
	Alleppey	7.1
19th	Alleppey	7.8
	Kozhikode	6.5
20th	Trivandrum	9.8
21st	Alleppey	7.1

2. Severe cyclonic storm in the Arabian Sea 25th to 30th June.

A well marked trough of low pressure lay off Kanara - Konkan coasts and neighbourhood in east Arabian Sea on 24th June. At the same time a low pressure area from the Bay had moved into the Peninsula and was lying over Andhra Pradesh and Mysore. This diffuse low pressure area later moved into the east central Arabian Sea, where a depression formed on the morning of 25th with centre at 0830 hrs IST near Lat. 18.5°N and Long. 71.0°E. Moving in a north-westerly direction, it was centred in the evening within half a degree of Lat. 19.5°N and Long. 70.0°E as could be seen from the strengthening of the upper winds over Veraval which became easterly 25 to 30 knots upto 3.0 kms in the evening. The pressure defect at Veraval was 4.6 mbs.

During the course of the night, the winds at Veraval veered and strengthened to about 25 knots with occasional squalls. The pressure defect at Veraval at 0830 hrs IST of 26th was 6.7 mbs. Apparently the depression had deepened and it was centred at 0830 hrs IST within half a degree of Lat. 21°N and Long. 68.5°E. At 1730 hrs IST, it was centred within half a degree of Lat. 22.0°N and Long.67.5°E. The maximum pressure defect was 8.7 mbs at Dwarka. On the same evening, upper winds over Varaval reached 40 to 50 knots from southwesterly direction below 3.0 km a.s.l.; many stations in Saurashtra and along extreme north Konkan coast reported strong gusty winds of 25/30 knots from southeast to south reaching 35 to 40 knots in gusts; frequent gales were reported from the coastal stations on 26th and 27th. Veraval recorded an average wind speed of 29 knots during the 24 hrs ending at 0830 hrs IST OF 27th. It is interesting to note that in spite of the proximity of the deep depression and the strong winds, the rainfall over Saurashtra was not heavy. On 27th morning only light to moderate rain was reported along the Saurashtra coast with little or no rain in Kutch and interior Saurashtra.

Continuing to move in a northwesterly direction, the deep depression was centred within half a degree of Lat. 23°N and Long. 66.5°E at 0830 hrs IST of 27th. At 1130 hrs IST, S.S. City of Colombo (Lat. 23°30'N and Long. 64°54'E) reported cyclonic storm winds west to north force 7/8, rough seas, bar. 29.35" falling rapidly. Apparently by this time, the depression had intensified into a cyclonic storm and was centred within half a degree of Lat. 24°N and Long. 66°E. For the next 24 hours, ships observations from the storm area were very few to fix the centre with confidence. However, by midday of 28th, the observations from the following two ships indicated that the cyclonic storm had become severe and was centred within one degree of Lat. 22.5°N and Long. 63.5°E.

1. Stanvac Palemarg : Time 1030 hrs IST. Lat. 22.0°N and Long. 64.2°E; course 135°, winds S/SW force 10; high seas; wind veering slowly counter clockwise; heavy rain; visibility very poor; bar 28.94", on 28.6.59.

2. Flying Fish : Time 1030 hrs IST; Lat. 23.36°N and Long. 65.0°E; wind ESE force 8/9; confused heavy sea and swell; barometer 29.17" rising slowly; sky overcast ; visibility 8/10 mls. occasional showers since 0630 hrs IST with steady ENE 8/9, on 28.6.59.

The pressure at the centre might have been less than 980.0 mbs (i.e. a defect of more than 25 mbs), at 0830 IST on 28.6.59.

The severe cyclonic storm apparently remained more or less stationary for the next 24 hours. The two nearest ships observations were those from Ship Cannanore and Lochfoda. Lochfoda (Lat. 24.7°N and Long. 63.4°E) at 2130 hrs IST of 28th reported eastnortheasterly 25 knots while Cannanore (Lat. 21°02'N and Long. 62°22'E) reported at 0830 hrs IST of 29th westnorthwesterly force 8 continuous heavy rain, very high seas and swell, barometer 29.26" uncorrected, steady, at 0830 IST on 29.6.59

Once again ships observations were absent until observations of ship S.S. Valletia at 2330 hrs IST of 29th and 0530 hrs IST of 30th (given below) were received. These observations together with those of S.S. President Jakson showed that the severe cyclonic storm had weakened into a deep depression while moving in a southeasterly direction and was centred at 0530 hrs IST of 30th within half a degree of Lat. 21.5°N and Long. 65.5°E.

OBSERVATIONS OF S.S. Valletia.

Date	Time	Position		Wind		PPP mbs	Weather	Wave height (metres)
		Lat. N	Long. E	Direction	Vel. Kts			
29/6	2330	22	66	120	26	993.0	Lightning seen	3
30/6	0530	22.4	65.0	050	24	991.8	Drizzle	3.5
"	1130	22.8	64.0	060	15	996.2	Cloudy	2

During the course of the 30th, the deep depression rapidly weakened into a trough of low pressure in situ.

The loop in the track was an unique feature of this severe cyclonic storm. Although there was lack of ships observations to fix the centres accurately at some of the synoptic hours, the available data, quoted above in full, clearly indicated the rather uncommon track.

In association with the formation and movement of this storm, the Arabian Sea branch of monsoon strengthened progressively along the west coast upto south Konkan by 24th. Subsequently, it rapidly extended northwards along the west coast where it established itself over the Konkan, Madhya Maharashtra, south Gujarat region and south Saurashtra by 26th morning. Some of the noteworthy amounts of rainfall associated with this cyclonic storm are : Sangli 24 cm and Ratnagiri 11.1 cm on 23rd, Amboli 25 cm, Mangalore 21 cm, Vengurla 10.5 cm, Cuddapah and Fort Cochin 9.3 cm each, Bijapur 8.9 cm, Honavar 7.9 cm on 24th, Sawantwadi (Ratnagiri) 18.1 cm, Harnai 11.2 cm, Karwar 10.6 cm, Ratnagiri 8.3 cm, Kozhikode 8.2 cm, Alleppey 7.5 cm and Mangalore 7.0 cm on 25th and Mangaon (Kolaba district) 20.5 cm, Alibag 14.5 cm, Bombay (Colaba) 9.0 cm, Bombay (Santacruz) 8.4 cm, Devgarh 7.2 cm and Honavar 7.1 cm on 26th.

In association with the advance of the monsoon into the Gujarat region, thunderstorms associated with squalls were reported from a number of places. Ahmedabad had thundersqualls on four consecutive days. On the 24th, the squall speed reached 60 kts at Ahmedabad and anemometer cups were blown off in the squalls. According to newspaper reports, the squalls disrupted telephone and telegraphic communications besides uprooting a number of trees and blowing off roof tops and huts-ments. The gales caused heavy damage in several parts of north Gujarat region. Strong winds caused dislocation of road traffic, power supply etc. and blowing up of roofs had also been reported from a number of places in Saurashtra.

3. Cyclonic storm in the Bay of Bengal - 27th June to 1st July
and
Deep depression in northeast Arabian Sea - 2nd and 3rd July.

A low pressure area formed in the central Bay of Bengal and neighbourhood on the afternoon of the 26th June. It became marked by the next morning when monsoon was strong to vigorous south of Lat. 14°N in the Bay of Bengal. By the same evening, the well marked low pressure area was concentrating into a depression with central region at 1730 hrs IST of 27th near Lat. 17.5°N and Long. 89.5°E. Akyab reported southeasterly winds of 30 kts and 40 kts at 0.6 km and 0.9 km a.s.l. respectively and a negative pressure departure of 6 mbs.

Thereafter, it further concentrated during the night and lay as a deep depression centred at 0830 hrs IST of 28th near Lat. 18°N and Long. 89°E.

Following ships' observations are of interest in this connection.

Date and Time IST	Name of the Ship	Position		Wind		PPP mbs	Weather
		Lat. N	Long. E	Direction Deg.	Vel. Kts		
280530	S.S.Jalajawahar	16.0	88.0	270	60	989.1	Heavy rain
280530	S.S. Choy Sang	19.5	89.0	070	20	989.3	Shower
280530	S.S. Alhasan	14.5	86.9	270	30	990.5	Heavy rain
280730	S.S. Purnea	18.3	90.2	160	20	988.0	Overcast

Ship's observations from the north and central Bay and upper winds of the order of 30/40 kts over coastal regions around north and central Bay together with negative pressure departure over the West Bengal - Orissa coasts of the order of 8 mb suggested that the deep depression intensified into cyclonic storm (estimated central pressure being 982 mb) and was centred at 1730 hrs IST of 28th near Lat. 18.5°N and Long. 88.5°E. Following ships' observations are relevant in this connection.

Date and Time IST	Name of the Ship	Position		Wind		PPP mbs	Weather
		Lat. N	Long. E	Direction Deg.	Vel. Kts		
281730	S.S.State of Orissa	19.8	90.4	150	30	990.2	Shower
281730	S.S. Jalajawahar	17.5	89.6	200	35	989.2	Rain
281730	S.S. Alhasan	14.9	86.5	270	30	993.6	Drizzle

Date and Time IST	Name of the ship	Position Lat. N	Position Long. E	Wind Direction Deg.	Wind Vel. Kts	PPP mbs	Weather
281730	Sandheads			020	20	989.2	Rain
281730	S.S. Indian Security	16.8	83.2	270	35	995.9	Showers
281800	City of Willington	19.3	86.3	360	25	992.2	Overcast

The cyclonic storm moved northwest and was centred at 0830 hrs IST of 29th near Lat. 19.5°N and Long. 87°E - estimated central pressure being 982 mb. Puri, Cuttack and Chandbali in the Orissa coast recorded negative pressure departure of 16 mb, 14 mb and 12 mb respectively. Following observations are also of interest in this connection.

Date and Time IST	Name of the ship/ station	Position Lat. N	Position Long. E	Wind Direction Deg.	Wind Vel. Kts	PPP mbs	Weather
282330	S.S.Jalajawahar	18.9	89.6	180	30	991.5	Overcast
282330	Sandheads			150	25	988.8	Overcast
290530	Sandheads			120	30	988.7	Overcast
290830	Sandheads			100	25	992.2	Overcast
290830	Puri			020	30	955.0	Rain
290830	Chandbali			070	20	988.4	Rain
290830	Bhubaneshwar			070	20	967.1	Rain

By the evening of the same day, the cyclonic storm over northwest Bay had just crossed coast near Puri and weakened into a deep depression.

The deep depression moved westnorthwest and lay over east Madhya Pradesh centred at 0830 hrs IST of 30th near Raipur. While moving westnorthwest it weakened further and lay as a depression over north Gujarat and adjoining Madhya Pradesh centred at 0830 hrs IST of 1st July about 80 miles (130 kms) to the northwest of Ratlam. Moving in a westerly direction and weakening, it induced a well marked trough of low pressure in the northeast Arabian Sea by the evening. The trough developed into a depression with centre at 0830 hrs IST of 2nd close to coast near Naliya. Later the depression took a northwesterly course and crossed Sind coast near Lat. 24°N by the early morning of 3rd.

Under the influence of these disturbances, the monsoon rapidly advanced and had established itself over the entire country outside Jammu and Kashmir, Himachal Pradesh, the Punjab (I) and west Rajasthan. The monsoon was strong to vigorous over Konkan and Gujarat State between 28th June and 1st July. Some noteworthy amounts of rainfall reported from Madhya Pradesh are : Sardarpur 24 cm, Narayanpur and Badnawar 14 cm each, Barwaha 12 cm, Harsud and Dhar 10 cm each on the 30th, Indore 17 cm, Maheswar 16 cm, Depalpore, Badnagore and Khandwa 15 cm each, Makrai 14 cm, Sarathi 13 cm, Ratlam 11 cm on the 1st July.

Significant rainfall in cms in Gujarat State and Konkan are given in the table below :

State	District	Station	29 June	30 June	1 July	2 July
Gujarat	Bhaunagar	Mahuva	..	17.7	..	..
	Mehsana	Harji	..	..	..	15.6
	Kaira	Mehmadabad	..	..	..	21.2
		Matar	..	..	..	22.6
		Mahudha	..	..	18.7	..
		Anand	..	..	..	16.1
		Tranza	..	..	..	18.2
	Nagrana Tanks	Pinglau	..	..	16.8	..
		Wanghroli Tank	..	..	..	15.0
	Panchmahals	Lunswada	..	..	17.6	..
	Zalwad	Dharangadhra	..	..	20.2	..
	Broach	Ilav	..	..	..	24.0
	Surat	Surat	..	..	9.6	..
		Mandvi	..	..	..	16.4
		Palsana	..	..	..	16.3
Maharash-tra	Thana	Vada	..	16.3	35.4	..
		Dahanu	..	18.0	22.1	..
		Jawhar	..	..	19.8	..
		Umbargaon	19.2	26.7	..	..
	Kolaba	Alibag	15.9	..	..	..
		Murud	19.2	..	..	..
		Mhasla	25.2	17.1	..	..
	Ratnagiri	Vengurla	16.3	..	..	..
		Devrukh	19.2	..	..	..
		Khed	..	30.2	..	..
		Dapoli	16.5	21.9	..	..
		Mandangad	18.3	25.4	..	..
		Kankavli	21.8	15.4	..	..
		Sawantwadi	18.8	23.8	..	..
		Kudal	..	16.9	..	..

4. Deep depression in the Bay of Bengal on 4th July

A low pressure wave from east was moving westwards across deltaic Burma on the morning of 1st July. On the 2nd morning it moved into the northeast and east central Bay where conditions became unsettled and negative pressure changes and departures were of the order of 3 mbs. Conditions became markedly unsettled over north Bay by the evening of 3rd when upper air cyclonic circulation was noticeable at least upto 4.5 kms above sea level. By the morning of 4th, the unsettled conditions developed into a depression in the northwest Bay and was centred at 0830 hrs IST near Lat. 19.5°N and Long. 87.5°E.

The depression moved west and was centred at 1730 hrs IST of 4th July near Lat. 19.5°N and Long. 86.0°E. Thereafter moving westnorthwest and weakening at the same time, the depression crossed coast between Puri and Gopalpur by the midnight of 4th July. It lay as a shallow depression near Lat. 22°N and Long. 80°E at 0830 hrs IST of 5th July, and as a low pressure area over northwest Madhya Pradesh and neighbourhood by the next morning.

In association with this depression, the monsoon advanced into Himachal Pradesh, the Punjab (I), Jammu and Kashmir and west Rajasthan thereby establishing itself over the whole of the country. Jammu reported 28 cm and Dharmsala 10 cm on 5th, Hissar 10 cm on 7th, Chandigarh 9 cm, Ludhiana 8 cm, Simla 8 cm and Hissar 7 cm on the 6th. According to newspaper reports, there were heavy floods in Jammu and Kashmir, resulting in considerable damage to standing crops and dislocation of communication.

5. Depression in the Bay of Bengal 10 - 15 July and Severe cyclonic storm in the Arabian Sea - 15 to 19 July.

On the morning of 9th July 1959, there was a general fall of pressure over India, East Pakistan and Burma, but the fall of pressure during the past 24 hours over the Arakan - Chittagong coast was of the order of 4 to 5 mbs with negative pressure departure of the order of 6 to 7 mb. The Arakan - Chittagong coast which recorded widespread rain with scattered heavy falls on 9th morning had also reported locally heavy to very heavy rain on the previous day. All these suggested that a low pressure wave from the east was moving into the north Bay across Arakan - Chittagong coast. Under influence of the low pressure wave from the east, a well marked low pressure area developed on the morning of 10th over Head Bay off Chittagong - Sunderban coast where negative pressure departure became of the order of 10 mb. On the same evening, a depression formed over East Pakistan and neighbourhood and was centred at 1730 hrs IST of 10th near Lat. 22°N and Long. 90°E.

The depression moved westnorthwestwards and lay at 0830 hrs IST of 11th centred close to but west of Asansol. A shallow low also formed on 11th morning over northeast Madhya Pradesh. On the next day, the depression merged with the shallow low and was centred at 0830 hrs IST of 12th just north of Jubbulpore. Moving westnorthwestwards, the depression lay over northwest Madhya Pradesh and neighbourhood with centre at 0830 hrs IST of 13th near Guna. It was centred near Deesa at 0830 hrs IST of 14th. Moving in a westsouthwesterly direction, the depression emerged out on the morning of 15th into the northeast Arabian Sea off Sind coast and was centred near Lat. 23.5°N and Long. 67.5°E at 0830 hrs IST of this day. For lack of observations, the position of the depression centre could not be located till midday of 16th.

By this time, it rapidly intensified into a cyclonic storm with centre within half a degree of Lat. 22.5°N and Long. 66°E. Ship Caltex Delft (22°N and 66.8°E) reported southerly winds of 42 knots at 1130 hrs IST, the wave heights reported by ships in northeast Arabian Sea and adjoining east central Arabian Sea were of about 2.5 m corresponding to moderate to rough seas. By 1730 hrs IST, the cyclonic storm was centred within half a degree of Lat. 22.5°N and Long. 65°E. Caltex Delft which was also moving in a westerly direction and was at this time about 100 kms east of the storm centre, continued to report southerly winds of speed 42 knots but the waves reported were of higher height (viz. 8 m) corresponding to high seas, indicating the storm was probably severe. The estimated central pressure was about 970 mb.

Continuing to move in a westerly direction, the severe cyclonic storm was centred near Lat. 22.5°N and Long. 64.0°E at 0830 hrs IST on 17th. Ship "Riyadhamaru" (Lat. 22.0°N and Long. 63.3°E) reported westerly wind of 45 kts at 1130 hrs IST on 17th. By this time the upper winds along Sind - Kathiawar coast had gone outside the grip of the cyclonic storm and the storm was apparently one of small extent. At 0530 hrs IST of 19th, available observations showed that the system had weakened into a depression and was centred near Lat. 23.5°N and Long. 60°E. It is difficult to say when exactly after 0830 hrs IST of 17th, the storm weakened into a depression. After 0530 hrs IST of 19th, the depression continued to move westnorthwesterly and apparently weakened and merged into the seasonal low over Oman area.

In association with the depression, widespread rainfall occurred in Gangetic West Bengal and Bihar Plateau on the 10th and 11th, in Madhya Pradesh on the 12th and 13th and in Gujarat State on the 14th and 15th. Some noteworthy amounts of rainfall are : Sambalpur 10 cm on 10th, Khitoli 22 cm, Satna 19 cm, Umaria 18 cm, Niwar, Shehone 14 cm each, Bechari 13 cm, Chattarpur 12cm, Hazaribagh, Nowgong; 11 cm each on 11th, Mandla 21 cm, Harsud, Narayanganj 19 cm each, Shehoni 17 cm, Dhar 14 cm, Saugor, Panna, Shajapur 12 cm each, Shahpur, Paibara, Niwas 11 cm each on 12th, Seoni 27 cm, Powar Kheda 26 cm, Harda, Budhi 24 cm, Makrai 22 cm, Kanod 21 cm, Hoshangabad, Kalaikhar 20 cm each, Indore, Nasrulgunj 18 cm each, Sohagpur 17 cm, Pachmari, Badnagar, Shahpur13 cm each, Mandhata 12 cm, Khandwa, Bairagarh 11 cm each, Ichawar 10 cm on 13th; Indore 11 cm, Idar, Rajkot 9 cm each on 14th, Dwarka 12 cm, Rajkot 8 cm on 15th.

Under the influence of the depression moving across Madhya Pradesh, the monsoon became strong to vigorous in northeast Arabian Sea on the 14th and 15th. Winds of speed ranging between 30 and 40 kts prevailed along Kathiawar coast and over Kutch and neighbourhood between the evening of 14th and the early morning of 15th. An average wind speed of 31 knots during the last 24 hours was reported by Veraval on the 15th morning.

In association with the movement of the depression across north Gujarat State, the monsoon activity strengthened considerably over Gujarat State and the north Konkan between 13th and 15th where widespread and locally heavy to very heavy rainfall occurred. Bhuj recorded 47 cm on 15th which is a record rainfall for the station and of this 31 cm fell between 1130 and 1730 hrs IST of 14th and 10 cm between 1730 hrs and 2330 hrs IST. Taking Kutch as a whole, the total rainfall during the three days (13, 14 and 15 July) was almost half the season's normal rainfall.

Selected heavy rainfall amounts (more than 7.5 cm at Observatory Stations and 12.5 cm at State raingauge stations) recorded in Gujarat and Maharashtra States during this period are given below :

State	District	Station	13th	14th	15th
Gujarat	Kutch	Bhuj	..	..	46.8
		Mandvi	..	23.4	..
		Anjar	..	..	13.5
		Naliya	..	23.8	..
		Mundra	..	13.8	..
		Bachawa	..	18.3	..
		Nakhatrana	..	26.5	..
		Lakhapat	..	12.8	..
	Saurashtra	Dwarka	..	..	11.9
		Rajkot	..	9.0	8.2
	Mehsana	Patna	..	18.3	..
		Kadi	16.4	..	..
		Vijapur	17.6	..	..
		Chanasama	..	15.7	..
		Harji	..	14.8	..
	Sabarkantha	Himatnagar	15.4	..	..
		Idar	..	8.8	..
		Byad	..	18.3	..
		Mohanpur	12.7	..	..
		Megharaj	..	13.3	..

State	District	Station	13th	14th	15th
		Kharaghoda	..	20.8	..
	Ahmedabad	Mandal	..	30.1	..
	Kaira	Thasara	13.2	..	..
		Wanghroli Tank	..	15.2	..
		Balasinor	..	15.8	..
	Panchmahal	Limkheda	15.7	..	..
		Baroda	..	7.8	..
		Dahanu	..	9.9	7.9
Maharashtra	Kolaba	Matheran	..	12.9	13.2
	Satara	Mahabaleshwar	..	..	10.9

According to the newspaper reports, the central and western divisions of Kutch comprising of Bhuj, Mandvi, Abadasa and Nakhatrana Talukas were the worst affected areas due to the floods caused by the heavy rains. About 17 lives were lost and the total number of house collapses and damages to houses (including Kutcha tenaments) were estimated to be of the order of 5,000 which rendered nearly 13,000 persons homeless. Breaches occurred on a large scale disorganising transport and bus service. At Bhuj, the streets were under 10 feet of water and people had to climb to house tops to save themselves from drowning.

6. Depression in the Bay of Bengal - 17 to 19 July

On the evening of 12th, a low pressure wave from east was moving into east Central Bay, as could be judged from the fall of pressure over Deltaic Burma and neighbourhood. Locally very heavy rain was recorded over the north Bay Islands by the morning of 13th. By this time, the low pressure wave moved into north Bay and adjoining central Bay where an upper air cyclonic circulation upto 2 kms a.s.l. was getting established. Conditions became unsettled by the morning of 14th over the north Bay and adjoining central Bay where the upper air cyclonic circulation extended upto 4.5 kms a.s.l. Conditions became markedly unsettled over the area on 16th morning as a fall of pressure of the order of 3 mbs was observed over north Orissa coast and neighbourhood.

On the morning of 17th, a depression formed over west central Bay centred at 0830 hrs IST of 17th near Lat. 17.5°N and Long. 88.0°E.

Following ships' observations are relevant in this connection :

Date and Time	Name of the Ship	Position		Wind		PPP Mbs	Weather
		Lat. N	Long. E	Direction Deg.	Vel. Kts		
170530	S.S. State of Kutch	18.1	85.1	360	20	995.2	Rain
170530	S.S. Jalaputra	16.8	91.4	240	25	994.8	Overcast

The depression moved northnorthwest and was centred at 0830 hrs IST of 18th near Lat. 19.0°N and Long. 87.5°E. Negative pressure departures over Orissa - West Bengal coasts was of the order of 6 to 7 mbs. Later, it moved northwards and was centred at 0830 hrs IST of 19th near Lat. 21.0°N and Long. 87.5°E. By the morning of 20th, it weakened into a trough of low pressure extending from Bihar Plateau to northwest angle of the Bay and merged into the seasonal trough of low pressure by the 22nd morning.

In association with the depression, fairly widespread rainfall occurred in the Bay Islands, Gangetic West Bengal, Orissa, Bihar Plateau, Madhya Pradesh and coastal Andhra Pradesh. The noteworthy amounts of rainfall are : Vishakhapatnam 10 cm, Seoni 14 cm, Sohagpur 25 cm, Power Kheda and Chachora 13 cm each, Sehore 12 cm on the 18th, Dhantari 15 cm, Basodi 13 cm, Rudri 12 cm, Bhopalpatnam 11 cm on the 19th.

7. Land depression over Bihar - 4 to 6 August

On the morning of 3rd August, a low pressure area developed over Gangetic West Bengal and adjoining and East Pakistan where there was widespread rain with scattered heavy falls. The low pressure area moved westnorthwest and intensified into a land depression over Bihar Plateau and adjoining Gangetic West Bengal with centre at 0830 hrs IST of 4th near Purulia. The upper air circulation associated with the land depression extended upto about 3 km a.s.l. Next day morning, the depression moved westwards and lay over northeast Madhya Pradesh centred at 0830 hrs IST of 5th about 100 kms east of Umaria. Moving westnorthwest, the depression lay on the morning of 6th over northwest Madhya Pradesh with centre at 0830 hrs IST about 50 kms south of Jhansi. The depression moved westnorthwest and weakened into a low pressure area over northwest Madhya Pradesh and adjoining Uttar Pradesh next day morning. It merged into the seasonal trough on the morning of 8th.

Under its influence, fairly widespread and locally heavy rain occurred in Madhya Pradesh, west Uttar Pradesh, Himachal Pradesh, the Punjab hills and east Rajasthan between 5th and 8th August. Some noteworthy amounts of rainfall reported are : Jabalpur and Sagar 10 cm each on the 5th, Satna 14 cm and Sagar 11 cm on the 6th. Other significant amounts and district averages are given below :

State	District	5th	6th	Particularly heavy falls
		cms		
Madhya Pradesh	Sagar	7.1	5.4	5th Pondilafe (Jbp) 15.8 cm, Khotaghat (Jbp) 12.5 cm, Sagor (Sagor) 10.2 cm, Rehli (Sagar) 13.2 cm, Mala (Sagar) 20.8 cm, Jabera (Damoh) 14.1 cm, Jabalpur (Jabalpur) 19.7 cm, Poriat (Jabalpur) 11.3 cm, Borima (Jabalpur) 10.3 cm, Niwar (Jabalpur) 12.4 cm, Adhortal (Jabalpur) 10.0 cm, Raisen (Raisen) 12.3 cm, Sehore (Sehore) 15.5 cm.
	Damoh	7.3	..	
	Jabalpur	7.5	..	
	Raisen	5.0	7.5	
	Sehore	..	6.4	
	Satna	..	6.8	
	Bilaspur	7.1	..	
				6th Sagar (Sagar) 10.5 cm, Khurai (Sagar) 18.2 cm, Begumganj (Raisen) 12.0 cm, Satna (Satna) 13.7 cm, Deori (Sagar) 12.7 cm, Salwani (Raisen) 18.3 cm

8. Land depression over Orissa - Madhya Pradesh - 10 to 15 September

Under the influence of a low pressure wave from the east, the seasonal trough over north Orissa, Bihar Plateau and adjoining Gangetic West Bengal and Madhya Pradesh was more marked on the morning of 7th September and persisted so for the next two days. On 9th morning a fresh low pressure wave from east was moving westwards across north Bay. On the morning of 10th, widespread rain with scattered heavy falls occurred over Gangetic West Bengal and Orissa. Under the influence of the low pressure wave from east, a land depression formed over north Orissa and adjoining areas of Gangetic West Bengal and Bihar Plateau with centre at 0830 hrs IST of 10th about 150 kms east of Jharsuguda. Upper air cyclonic circulation associated with the depression extended upto about 6 kms a.s.l. Persisting over the same area for the next day, the depression moved westwards and deepened. It was centred at 0830 hrs/* IST of 13th about 100 km east of Gondia. Moving westwards, the deep depression lay at 0830 hrs IST of 14th centred near Nagpur. Later it moved northwest, weakened and was centred on the morning of 15th about 100 kms north of Indore. It weakened further and merged with the seasonal low over West Pakistan by the morning of 16th. /* IST of 12th about 50 km west of Jharsuguda. Subsequently, the deep depression moved west-southwestwards and was centred at 0830 hrs/

District averages and significant amounts of rainfall in association with this land depression are given below :

State	District	11th	12th	13th	14th	15th	Particularly heavy falls (cms)
Madhya Pradesh	Durg	..	..	8.2	..	..	11th - Jamatara (Santhal Pg) 13.5, Nawapara (Kalahandi)32.2, Durg (Durg) 11.1, Jashpurnagar (Raigarh) 10.3, Bhopalpatnam (Bastar) 14,3. 12th - Jamatara (Santhal Pg) 11.5, Sonua(Singhbum) 11.9, Admabad (Durg) 10.2, Selod (Durg) 10.2, Gariabund (Raipur) 14.6, Rajum (Raipur) 13.3, Mahasamud (Raipur) 12.3, Lokholi (Raipur) 10.9, Rudri (Raipur) 12.7, Maramsilli (Raipur) 12.3, Gattasilli (Raipur) 16.0, Raigarh (Raigarh) 14,3, Sarangarh(Raigarh) 14,2, Autagarh (Bastar) 11.2. 13th - Jamatara (Santhal Pg) 11.0,Durg (Durg) 14.4, Adamabad (Durg) 13.7,Selod (Durg) 11.6, Rajnandgaon (Durg) 11.3, Dhamtari (Raipur) 13.8, Rudri (Raipur) 14.5, Kanki (Raipur) 11.3, Raigarh (Raigarh) 13.6, 14th - Jamatara (Santhal Pg) 11.5, Mandhate (Nimar) 10.0, Betul (Betul) 14.2, Tamia (Chhindwara) 20.0, Manpur-Tappa (Indore) 10.3, Burwaha (Nimar) 10.9, Dhar (Dhar) 29.7, 15th - Depalpur(Indore) 13.1, Khargone (Khargone) 12.5, Borwani (Khargone) 21.6, Rajput (Khargone) 27,4, Dhorampuri (Dhar) 13.2, Sardarpur (Dhar) 15.4, Manawar (Dhar) 28.3, Jhabua (Jhabua) 14.1, Alirajpur (Jhabua) 10.5.
	Raipur	..	7.8	6.8	..	..	
	Raigarh	..	..	6.8	..	..	
	Bastar	6.4	5.4	..	..	..	
	Nimar	..	..	..	9.1	..	
	Betul	..	..	..	6.9	..	
	Chhindwara	..	..	..	5.7	..	
	Ratlam	..	..	..	5.4	..	
	Mandsaur	..	..	..	4.9	..	
	Dewas	..	..	..	..	4.9	
	Indore	..	..	..	5.2	7.7	
	Nimar (Khargane)	..	..	..	5.1	17.5	
	Dhar	..	..	..	8.8	11.7	
	Jhabua	..	..	..	..	12.3	

9. Severe Cyclonic storm in the Bay of Bengal - 27 Sept. to 2nd Oct.

On the evening of 25th September, Port Blair reported strong westerly upper winds of 30/60 knots in the lower troposphere and Rangoon easterly upper winds of 10/15 knots. Fairly windespread rain occurred in the Bay Islands of Tenasserim. Pressure departure of Tavoy was lowest and it was apparent that a low pressure wave from the east was moving into the north Andaman Sea. On the 26th morning, a cyclonic circulation extending upto 4.5 km a.s.l. lay over the north Andaman Sea. By the 27th morning the circulation shifted into east central Bay of Bengal and developed into a depression centred at 0830 hrs IST near Lat.15.5°N and Long. 92°E. It then moved northwest and was centred near Lat. 18.5°N and Long. 89.5°E at 0830 hrs IST of 28th, near Lat. 19.5°N and Long. 89.0°E at 0830 hrs IST of 29th and near Lat.20.5°N and Long.88.5°E at 1730 hrs IST of the same date. The depression thereafter remained practically stationary and intensified by 0530 hrs.IST on 30th into a cyclonic storm and intensified further into a severe cyclonic storm by 0830 hrs. IST of the same day, remaining centred near Lat. 20.5°N and Long.88.5°E. Sandheads reported northeasterly winds of 45 knots at 0530 hrs IST of 30th and NNE 50 knots at 0830 hrs IST. At 1130 hrs IST of 30th, S.S.Jaladhruva (Lat.19.9°N and Long.86.8°E) reported winds northnorthwesterly of 40 knots and S.S.Mariekerk (Lat. 21.0°N and Long.91.5°E) eastsoutheasterly winds of 40 kts. The severe cyclonic storm continued to move northwestwards and crossed West Bengal - north Orissa coast near Balasore by the night of 30th. At this time, estimated central pressure was about 976 mb with a barometric depth nearly 30 mb at the centre. The observations of Balasore, given in the table below indicates the presence of an eye of the storm which passed near Balasore.

Moving northwestwards the serve storm weakened later and lay as a deep depression with its centre at 0830 hrs IST of 1st October near Chaibasa. Continuing to move northwestwards it weakened further and lay as a depression over Bihar Plateau and adjoining northeast Madhya Pradesh centred at 0830 hrs IST of 2nd October close to Ranchi. By 0830 hrs IST of 3rd, it weakened further and lay as trough of low pressure extending from Bihar Plateau to Gangetic West Bangal.

A statement showing the summary of observations in respect of winds recorded at the observatories in the storm field during the period from 30.9.59 to 3.10.59 as available from MMR's and anemograph records of respective stations is given below:

Name of the Observatory	Maximum wind speed Recorded						Remarks
	Kts.	Time	Date	Kts.	Time	Date	
1	2	3	4	5	6	7	8
Sandheads	50	0830	30				Wind became strong from midnight of 29.9.59 with occasional gales during the whole day of 30.9.59. The vessel left its position by noon of 30th.
Saugor Island	64	2100	30				Gusty wind started from the evening of 29th. Gusty winds with occasional squalls reaching gale force throughout day of 30th.
Alipore (Calcutta)	43 (Anemogram)	2140	30				Surface wind became gusty with occasional squalls and gales from the morning of 30th till midday of 1.10.59.

1	2	3	4	5	6	7	8
Dum Dum (Calcutta)	44 (Anemograph Record)	1729	30				Surface wind became gusty with occasional squalls and gales from the morning of 30th till midday of 1.10.1959.
Balasore				59	2100	30	Since midday of 30th, gusty wind with occasional squalls continued upto about 0200 hrs IST of 1st. There was lull in wind for about half an hour from 2030 hrs IST of 30th. Wind speed decreased and changed from NE to S when violent wind of speed of about 59 kts was estimated. After mid-night wind speed began to decrease
Asansol				36	....	1	Gusty wind throughout the day on 1st.
Suri				36	....	1	Gusty wind with occasional squalls throughout the whole day of 1st.
Dhanbad				31	on early morning of 1st		Gusty wind throughout the whole day of 1st.
Jamshedpur	47 (Anemograph record)	0645	1				Gusty wind with occasional squalls from morning of 30th and continued till midday of 1st.
Gaya	52 (Anemograph Record)	1530	1				Gusty wind with occasional squalls commenced from the morning of 1st and continued till about midday of 2nd.
Patna				52	0100	2	Surface wind became gusty from 1000 hrs IST of 1st and continued till evening of 2nd.
Daltonganj				22	1300 -1500	1	
Varanasi (Babatpur)	35	1200	1				Gusty wind commenced from 1000 hrs IST of 1st and continued upto afternoon of 2nd.

A noteworthy feature in association with this cyclonic storm was the widespread rain with locally very heavy falls that occurred in Gangetic West Bengal and the adjoining areas of Bihar and in Orissa to the north/northeast sector of the storm between 30th September and 3rd October. Some of the noteworthy amounts of rainfall recorded are given in the table below. According to press reports, the cyclonic storm caused gales and very heavy rain and widespread floods in many districts of West Bengal and north Orissa resulting in large loss of life and property. The storm blew off hundreds of kutcha houses, uprooted a large number of trees and electric and telegraph poles and disrupted telecommunications and power supply in many districts of West Bengal, Bihar and Orissa. Many rivers in these areas rose in spate, several people were killed and large tracts of paddy fields were submerged under water. It was also reported that the low lying areas in the city of Calcutta were heavily flooded for two days paralysing traffic and throwing life in the city out of gear.

RAINFALL DATA (IN CMS) OF GANGETIC WEST BENGAL, NORTH ORISSA, BIHAR AND ADJOINING DISTRICTS OF UTTAR PRADESH DURING THE PERIOD 30 SEPTEMBER TO 3RD OCTOBER 1959 RECORDED AT 0830 HRS IST

Station	30.9	1.10	2.10	3.10
Gangetic West Bengal				
Sagar Island	..	21.1	..	..
Alipore (Calcutta)	..	20.6	..	..
Dum Dum (Calcutta)	..	15.0	..	..
Contai	..	20.3	..	..
Midnapore	..	11.1	..	..
Krishnanagar	..	17.3	21.5	..
Berhampore	..	..	22.2	..
Asansol	..	8.1	9.5	..
Suri	..	..	13.6	..
Burdwan	..	21.6	..	..
Diamond Harbour	25.7	..	..	..
Budge Budge	..	18.0	..	..
Bongaon	20.3	15.2	..	..
Haringhata	8.4	8.4	..	..
Azimganj	..	..	10.2	15.2
Sagardighi	..	19.1	12.98	22.0
Tamluk	..	15.5	..	..
Ramnagar	11.6	..	..	..
Kharagpur	14.0	..	..	..
Hooghly	11.4	..	..	..
Tarakeswar	16.0	..	..	..
Bihar Plateau				
Dumka	..	..	18.4	..
Hazaribagh	..	..	10.4	..
Jamshedpur	..	11.5	..	..
Dhanbad	..	..	11.1	..
Bisnugarh	..	..	20.0	..
Dumri	..	..	23.7	..
Panchet	..	..	18.2	..
Maithon Dam	..	..	15.2	..
Durgapur	..	13.9	..	..
Bihar Plains				
Patna	..	..	10.0	..
Purnea	..	..	9.9	17.5
Sabour	..	..	9.4	11.4
Uttar Pradesh				
Gorakhpur	..	..	..	10.6
North Orissa				
Chandbali	11.2	11.2	..	..
Balasore	..	19.9	..	..

10. Severe cyclonic storm in the Arabian Sea - 10 to 18 October

A well marked low pressure area from west central Bay of Bengal moved northwestwards across coastal Andhra Pradesh and lay on 9th morning over Telangana. At the same time a low pressure area developed over east central Arabian Sea off Konkan coast. The low over Telangana apparently moved westnorthwestwards and accentuated the low pressure area over the east central Arabian Sea on 10th and a depression formed on the evening of 10th centred at 1730 hrs IST near Lat.19.5°N and Long. 71.5°E. Moving in a northnortheasterly direction and deepening, it crossed coast between Mahuva and Bhavnagar during the early morning of 12th and lay at 0830 hrs IST as a deep depression over east Saurashtra. Beginning from the evening of 11th strong winds reaching gale force were reported along the south Saurashtra coast for about 24 hours. The pressure defect was about 9 mb at the centre on 12th morning. The deep depression persisted over Saurashtra till 15th.

In association with the depression fairly widespread rainfall was reported from north Konkan, south Gujarat Region and Saurashtra on most of the days during the period 10th to 14th with locally heavy to very heavy falls on a few days. Fairly widespread rainfall with a few heavy falls was also reported from north Madhya Maharashtra on 10th when Nandurbar recorded 16 cm. The other noteworthy amounts of rainfall (of 9 cm or more) recorded during the period are given below :

District	Station	10	11	12	13	14	15	16
SAURASHTRA AND KUTCH								
Rajkot	Rajkot	..	..	..	..	9.1	10.6	..
	Jasdan	..	..	9.4	..	..	..	..
Bhaunagar	Jafarabad	..	..	..	..	13.7	..	..
	Mahuva	..	12.8	..	..	..	..	..
Junagarh	Veraval	..	..	..	..	9.6	..	..
	Porbandar	..	..	21.4	..	..	..	..
Amreli	Amreli	..	..	..	11.6	..	..	..
	Khamba	..	..	..	13.2	..	16.8	..
	Kodinar	..	..	..	..	..	..	11.1
SOUTH GUJARAT REGION								
Broach	Ilav	..	..	..	14.4	11.2	..	..
	Dahaj	..	..	..	..	8.1	..	..
Surat	Surat	..	..	..	12.4	..	..	..
	Olpad	..	..	..	12.2	..	..	..
	Jabalpur	..	..	..	9.1	..	..	..
	Bulsar	..	..	..	11.9	..	..	..
	Pardi	..	..	..	15.5	..	..	..
	Dharampur	..	..	12.9	..	..	..	..
	Navasari	..	..	..	9.1	..	..	..
	Ganderi	..	..	..	9.5	..	..	..
	Palsana	..	..	..	11.2	..	..	..

contd.

District	Station	10	11	12	13	14	15	16
MAHARASHTRA								
Thana	Thana	..	9.5	..	..	..	..	..
	Bassein	..	12.5	..	..	..	..	..
	Mahim	..	10.1	..	..	..	..	..
	Dahanu	..	..	..	17.3	..	..	..
Bombay	Borivili	..	10.7	..	..	..	..	..
Kolaba	Panvel	..	11.8	..	..	..	..	..
	Matheran	..	10.8	..	..	..	..	..
	Pen	..	11.6	..	..	..	..	..
	Murud	..	9.5	..	..	..	..	..

This spell of heavy rainfall in Saurashtra resulted in the collapse of many houses and loss of human lives. Several hundred heads of cattle were also reported to have perished. According to press reports, Mahuva and Porbandar were completely isolated from the rest of Saurashtra due to the heavy rains and resulting floods. Some parts of Mahuva town were under four feet of water.

On the morning of 15th, the winds at Veraval began to weaken. The surface winds backed rapidly from northwest through south to easterly between 0500 hrs and 0800 hrs IST. Coupled with the falling pressure, it was clear that the deep depression over Saurashtra was taking a very unusual south southwesterly course and emerging into northeast Arabian Sea just west of Veraval; the centre was very close to Veraval at 0830 hrs IST. At the same time, Keshod (30 miles due north of Veraval) was reporting easterly 27 knots. These, together with the 0830 hrs IST of observations from the other stationsiin Saurashtra, suggested that in the wind structure of the depression field, there was an area of very light winds at the centre.

During the next 3 to 6 hours, the deep depression rapidly intensified into a cyclonic storm. By 1130 hrs IST surface winds at Veraval rose to 25 knots reaching about 40 knots in gusts. For the next few hours, winds of gale force blew at Veraval; the highest speed reached in gust was 108 kmph (58 knots) at about 1430 hrs IST. However, the pressure departure at Veraval was only (-8.4 mb) at 0830 hrs IST. The cyclonic storm was centred at 1130 hrs IST near Lat.20.5°N and Long. 70.0°E.

Ship S.S. Burma Star (Lat. 20.36°N and Long. 69.12°E) reported at 1600 hrs IST a steadily falling bar and a veering of the wind from westnorthwesterly to north, force 5 to 6 BF. In the meantime S.S. Nagauramaru also reported winds of 35/40 knots between 1430 and 1630 hrs IST (Details are given below).

Observations from S.S. Nagauramaru
on 15 Oct. 1959

Time IST	Position Lat. °N	Long. °E	Wind Direction Deg.	Velocity Kts.	Weather Present	Past
1430	21.1	69.9	070	40	Moderate rain	Rain
1530	21.2	69.6	050	40	Rain in last hour	Drizzle
1630	21.4	69.5	050	34	Cloudy	Rain

The above observations confirmed the position of the cyclonic storm estimated from the observations of Veraval. The centre could be located at 1730 hrs IST within half a degree of Lat. 20°N and Long. 70°E. The available data showed that the area of winds exceeding gale force (30 kts) did not extend beyond a radius of 80 to 100 miles from the centre.

For the next 24 hours or so, there were no ships observations close to the centre; with the available observations (one of which within 1 to 1.5 degrees from the centre), the positions of the cyclonic storm were fixed successively within half a degree of accuracy as follows :

16.10.59	0530 hrs IST	19°N	69°E
	1130 hrs IST	19°N	68°E
	1730 hrs IST	19°N	67°E
	2330 hrs IST	19°N	66°E

From the early morning of 16th, the cyclonic storm had changed its direction from southsouthwesterly to west.

S.S.Udomaru, which was moving across the cyclone track in the southeasterly direction on this day, reported the following observations. The ship must have apparently passed close to the centre of the cyclonic storm (to the west or southwest of it) between 1730 hrs IST and 2330 hrs IST; but no details are available.

Observations from S.S. Udomaru on 16.10.59

Time IST.	Position Lat. °N	Long. °E	Wind Dir. deg.	Vel. kts	Weather	Pressure tendency	Waves Dir. deg.	Period Sec.	Height m.
1130	20.2	64.3	320	15	Cloudy	1.2	270	6-7	1
1730	19.3	65.5	360	15	Cloudy	-4.2	060	12-13	2.5
2330	18.4	66.7	230	25	Cloudy	2.5	250	12-13	2.5

However, on the 17th two ships S.S. Bedford and Tanker Neapolio came into the inner storm field. Their observations are reproduced below :

Time IST	Position Lat. °N	Long. °E	Wind Dir. Deg.	Vel. kts.	Weather	Pressure (mbs)	Pressure Tendency	Remarks
	Observations from S.S. Bedford on 17th October							
0820	20.0	64.3	045	44	--	1005.8	Falling	--
1230	19.2	64.0	045	56	Heavy rain	995.6	Falling rapidly	--
	Observations from Tanker Neapolio on 17th October							
0830	20.0	64.0	045	37	--	1013.9	Falling	--
1200	19.0	64.0	Variable		--	973.0	--	Ship suspected to have passed centre of cyclonic storm at this time.
1500	18.5	64.1	180	48	--	985.0	--	--

These observations indicated that the cyclonic storm had become severe and had a calm centre. It was centred at 1130 hrs IST near Lat. 19°N Long. 64°E and was one of small extent. The lowest pressure at the centre was 973 mbs (recorded by Tanker Neaploio at 1200 hrs IST) which gives the depth of the cyclonic storm as 37 mbs. Assuming that the pressure values reported are correct, there was a gradient of 0.24" (8 mb) within half a degree of Long. (i.e. nearly 1 mb per 4 miles) a little away from the centre and 23 mb in 0.2 of a degree of Long. (i.e. nearly 2 mb per mile close to the centre).

After the evening of 17th, there was a complete lack of observations from the storm area till the midday of 18th. The centres could therefore be fixed only by extrapolation. The severe storm continued in a straight westerly course and was within half a degree of Lat. 19°N and Long. 63°E at 1730 hrs IST of 17th and Lat. 19°N and Long. 60°E at 0830 hrs IST of 18th.

By the morning of 18th, winds along the Arabian coast began to strengthen and Masirah reported NE-30 knots with present weather dust-raising winds at 0830 hrs IST, NE-40K and rain at 1130 hrs IST and NE-35K and heavy showers at 1430 hrs IST. The following ships observations were also received from the area during the course of the day.

Ships' observations on 18th October

Name of the ship	Time IST	Position Lat. °N	Long. °E	Wind Dir. Deg.	Speed B.F.	Sea	Visibility	Remarks
Halcyormed	1130	21.25	59.40	045	7/8	Very rough	--	
Bahama Count	1130	19.06	58.40	045	9/10	Very rough and confused	Poor	
British Duchessi	1530	19.37	58.30	045	12	Very heavy seas	Nil	
- do -	1730	20.00	58.40	090	12	- do -	Nil	Indicates that the ship passed through centre of cyclone

By the morning of 18th, the severe cyclonic storm had developed a core of hurricane winds and was centred at 1130 hrs IST of 18th near Lat. 19°N and Long. 59.0°E and at 1730 hrs IST near Lat. 19°N Long. 58.0°E. During the course of the night it apparently crossed Kuria-Muria coast near Lat. 19°N.

A 180 ton cargo vessel "Premasavai" laden with goods worth Rs. 40,000/- sank off the Kathiawar coast being caught in the gales and squally weather caused by the cyclonic storm. A number of country craft and fishing boats have also been reported to have been lost off Veraval, Diu, Mahuva and Surat.

The interesting features of the cyclonic storm were :

i. The unusual southerly movement in the development stage on the 15th.
ii. Very rapid intensification from a deep depression into a cyclonic storm.
iii. A calm centre with a pressure defect of 37 mb and gradient of the order of 2 mbs per mile near the centre.
iv. Development of a core of hurricane winds at the later stages.
and v. Rapid falling off of winds strength beyond 80-100 miles from the centre.

11. Deep depression in the Bay of Bengal 27 to 30 October.

Under the influence of a low pressure wave from the east, the seasonal trough of low pressure over the southwest and adjoining southeast Bay became well marked on 26th. It intensified into a depression on 27th with centre at 0830 hrs IST near Lat. 9.5°N and Long. 82.0°E. Hambantota upper winds, available upto 600 m a.s.l. were 30 to 40 kts at 2330 hrs IST of 27th, indicating that the depression was intensifying. On the 28th morning it lay as a deep depression centred at 0830 hrs IST near Lat. 13°N Long. 82°E. It then took a northeasterly course and was centred at 0830 hrs IST of 29th near Lat. 18°N and Long. 86°E. S.S. Bharat Veer (19°.0 N, 87°.2 E) reported winds SE 30 kts with present weather rain and thundershower in last hour. It continued to move northeastwards and crossed east Sundarbans in the morning of 30th between Chittagong and Barisal, weakened and lay at 0830 hrs IST of 30th as a depression over south Assam with centre near Agartala. It weakened further and moved eastwards and broke up against the Assam hills during the course of the day.

Under its influence, nearly general rain occurred in the Madras State between 26th and 28th and in coastal Andhra Pradesh on 28th. Fairly widespread rain or thundershowers occurred in Kerala, north Madras State, coastal Andhra Pradesh and Orissa on 29th, in coastal West Bengal on 29th and 30th and in Assam on 30th. Heavy to very heavy falls were reported from a number of stations in coastal Madras State on 27th and 28th; from a few stations in coastal Andhra Pradesh and Kerala on 28th, coastal Orissa and coastal West Bengal on the 29th and from Assam on the 30th. Some noteworthy amounts of rainfall were : Nagapattinam 14 cm on 27th and 8 cm on 28th; Madras 8 cm each on 27th and 28th; Cuddalore 9 cm on 27th; Nellore 13 cm and Palghat 10 cm on 28th, Salem 11 cm, Chandbali 10 cm, Gopalpur and Saugor Island 9 cm each and Ootacamund 8 cm on 29th; Haflong 24 cm, Silchar 10 cm and Imphal 8 cm on 30th.

12. Depression in the Bay of Bengal - 28 November and in the Arabian Sea - 29th November to 6th December.

Pressure changes and departures, widespread moderately heavy to very heavy rain in the Bay Islands and lower level southeasterly upper winds of Port Blair suggested that a low pressure wave from east was moving westwards across extreme south Bay on the 26th morning. Under its influence, the seasonal trough of low pressure over the southwest Bay and the adjoining southeast Bay became well marked on the 27th morning when S.S. Nichiyamaru (5°7N; 88°2E) reported SW/15K, Trincomalee NW/10K and Hambantota N/10K. Fairly widespread rain was also reported from Ceylon on the same morning. The trough of low concentrated into a depression which was centred at 0830 hrs IST of 28th near Lat. 10.0°N and Long. 80.5°E. The depression moved westwards and crossed Coromandal coast south of Nagapattinam in the evening. Moving further westwards, it emerged into the Arabian Sea next day. It was centred near Lat. 10.0°N and Long. 75.5°E at 0830 hrs IST of 29th and near Lat. 10.0°N and Long. 71.0°E next morning. During the next two days, available ships' observations, though few, showed that the depression was taking a west-southwesterly course and it could be centred near Lat.9.5°N and Long. 68.5°E on the the morning of 1st December, near Lat. 8.5°N and Long. 67.0°E on the 2nd and near Lat. 8.5°N and Long. 65.0°E at 0830 hrs IST of 3rd December. On the next morning, the depression was centred near Lat. 8.5°N and Long. 63°E. S.S. Strathaird which crossed the centre of the depression near about 2330 hrs IST of 4th December from the west, reported at 0130 hrs IST of 5th northeasterly wind force 6, calm wind at 0200 hrs IST and south-southeasterly wind force 6 at 0230 hrs IST of 5th. These, together with the observations of S.S. Kieldrecht showed that the depression was one of small extent and the wind speed within the depression area did not exceed BF 6.

Moving in a westerly direction, the depression centre was within half a degree of Lat. 8.5°N and Long. 60.0°E at 0830 hrs IST of 5th and Lat. 8.5°N and Long. 57.5°E at 1730 hrs IST of 6th. At this stage strong northerly or northeasterly winds of speed about 30 knots were reported by ships in the northwest quadrant of the depression. These strong winds were probably only part of the strong seasonal northeast trades which prevailed over the Arabian Sea west of Long. 63°E and not any significant pointer to the intensity of the depression. This region of strong winds was fairly extensive and covered the entire Arabian Sea west of Long. 63°E upto the Arabian coast and was in existence from the 3rd onwards, with northnortheasterly winds of speed 25 to 30 knots. While crossing this region of strong winds, S.S. Strathaird reported at 1030 hrs IST of 4th (when the ship was nearly 700 km westnorthwest of the centre of the depression) heavy rain squalls gusting to force 8 and waves of height 4.5 m (very rough seas); Owing to absence of observations from the area of the depression it was not possible to follow the track of the depression after 6th evening.

The passage of the above disturbance from southwest Bay to southeast Arabian Sea caused fairly widespread rain between 28th and 30th in Madras State; locally heavy to very heavy falls were reported on 29th. Some of the noteworthy amounts of rainfall recorded on 29th are : Kallakkurichchi 27 cm, Madras 15.0 cm, Vellore 13.7 cm, Mathurai 11.1 cm and Kodaikanal 10.9 cm.

According to newspaper reports, the very heavy rainfall caused considerable dislocation in the train service over the southern railway on the Vilupuram-Tiruchi chord line due to flooding of the track. Breaches were also reported to have occurred on the trunk road near Villupuram (south Arcot District).

13. Depression in the Bay of Bengal – 5th to 7th December 1959

On the 3rd morning pressures were falling in the south Andaman Sea with fairly widespread heavy rain in the south Bay Islands. There was strengthening of upper winds of Victoria Point. This suggested that a low pressure wave from the east was moving across south Andaman Sea on the morning of 3rd. By the same evening S.S. Mikunimaru (7.2°N; 92.0°E) reported surface wind W/20 knots and present weather continuous heavy rain indicating that conditions were becoming unsettled in the southeast Bay and adjoining south Andaman Sea. By the 4th evening conditions became markedly unsettled when Carnicobar reported upper winds south to southsouthwest speed 20 knots and Port Blair reported strong upper winds from eastsoutheast.

By the 5th morning, a depression formed in the southeast Bay with centre at 0830 hrs IST near Lat. 11°N and Long. 90°E and at 1730 hrs IST near Lat. 12.5°N and Long. 89.0°E. S.S. Bharat Vijaya (Lat. 12.3°N and Long. 86.0°E) reported surface wind northwest 20 knots and present weather continuous heavy rain. Continuing to move in a northwesterly direction, the depression was centred at 0830 hrs IST of 6th within half a degree of Lat. 13.5°N and Long. 87.0°E. The following ships' observations are relevant in this connection :

Name of the ship	Date and Time IST.	Position		Wind		Weather	Pressure in mbs
		Lat. °N	Long. °E	Dir. Deg.	Vel. Kts.		
City of New Port	060930	15.5	84.5	045	30	Rain	1009.0
Bharat Vijaya	060530	12.5	84.8	270	20	-	1011.6
Bharat Veer	060530	11.4	83.9	290	15	Drizzle	1010.5
Alsayyada	060530	16.0	87.9	110	10	-	1010.1

At 1730 hrs IST of 6th, the depression was centred near Lat. 14.5°N and Long. 85°E. S.S. Alsayyada (14°N; 86.4°E) reported surface winds S/20 knots and S.S. City of New Port (Lat. 16.9°N; Long. 84.7°E) reported surface wind NNE/35 knots. Later, the depression moved westwards and was centred at 0830 hrs IST of 7th near Lat. 14.5°N and Long. 82.5°E. Thereafter, it weakened and passed inland across south Circars coast as a low pressure wave by the morning of 8th.

In association with the depression fairly widespread rain occurred in the Bay Islands from 3rd to 6th and local showers in coastal Andhra Pradesh on 8th. Some of the heavy rainfall amounts reported are Kondul 7.7 cm and Nancowrie 6.5 cm on 3rd, Car Nicobar 8.4 cm on 4th and Maya Bandar 8.5 cm on 5th.

II ACCOUNT OF WESTERN DISTURBANCES DURING 1959

The noteworthy features of the western disturbances that affected northern India in 1959 were as follows :

(a) A large number of active western disturbances affected northern India during January and the first half of February resulting in excess of rainfall over Jammu and Kashmir, the Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Assam.

(b) Rainfall was scanty in Jammu and Kashmir and weather was dry over the rest of northwest India during the whole of March due to the absence of active western disturbance.

(c) A dry spell over the entire north India outside Jammu and Kashmir commenced on the 9th of November and lasted till the end of the year due to the absence of active induced lows.

A list of the disturbances classified according to the nature of precitation caused by them is given in the table below. A description in detail of some of the more important western disturbances is also added.

Nature of precipitation	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Fairly widespread	5	5	2	0	2	0	2	1	0	3	2	0
Local	1	1	4	2	2	1	3	2	2	0	0	2
Scattered or no rain	3	4	2	6	3	5	5	7	4	2	5	5
No. of western disturbances in each month	9	10	8	8	7	6	10	10	6	5	7	7

1. Western disturbance during the period 2 to 5 January :

This disturbance appeared over Baluchistan and adjoining parts of Afghanistan on 2nd. It moved slightly northeastwards and became more marked by the 3rd. Moving in a more easterly direction thereafter, it lay over the northern divisions of the Punjab (P) on the morning of the 4th and over north Punjab (I) and Himachal Pradesh by that evening. It moved away eastwards through east Kashmir on the 5th. This disturbance caused fairly widespread or local rain or snow in Himachal Pradesh on 4th and 5th, Jammu and Kashmir 4, 5 and 7th and the hills of Punjab on 5th. Fairly widespread or local thundershowers also occurred in northwest Uttar Pradesh and the plains of Punjab (I) on 5th.

2. Western disturbance during the period 18 to 19 January :

This disturbance appeared over Baluchistan and adjoining Afghanistan on the evening of 18th. It moved eastwards and lay over northwest Rajasthan and adjoining parts of West Pakistan on the morning of 19th. It then moved in a northeasterly direction and lay over Himachal Pradesh, Punjab hills and adjoining Kashmir by that evening. It moved away further eastwards by the morning of 20th.

3. Western disturbance during the period [illegible] :
19 to 23 January :

This disturbance lay over north Afghanistan on the 19th. It moved across the extreme north of the country on the 20th and had moved away further eastwards by the morning of 21st. An induced trough developed over the Punjab on

the morning of 20th. This moved eastwards as a low pressure wave right across the foot hills of the Himalayas and was over Nepal - Himalayas on 21st and over northeast Assam on the 23rd. Under influence of the above two systems, fairly widespread or local snowfall occurred in Jammu and Kashmir, Himachal Pradesh and Punjab hills between 19 and 21. The Kumaon hills also recorded widespread snow on 21st. Local or scattered thundershowers were also reported from the plains of Punjab (I) and of west Uttar Pradesh between 19 and 21, and from east Uttar Pradesh on 20 and 21.

4. Western disturbance during the period 24 to 28 January :

This disturbance moved into north Baluchistan and adjoining Afghanistan on the morning of 24th. It induced a low pressure area over west Rajasthan and adjoining Sind that evening. The western disturbance moved across the northern divisions of West Pakistan on the 25th and moved away eastwards across Kashmir on the 26th. The induced low weakened and moved as a feeble trough across Nepal and eastern Himalayas and could be seen moving away eastwards across extreme northeast Assam on the morning of 28th. This system caused fairly widespread rain or snow in Kashmir and Himachal Pradesh on 26th. Local storms were also reported from Himachal Pradesh, west Uttar Pradesh and Bihar Plains on 27th.

5. Western disturbance during the period 2 to 5 February :

A western disturbance appeared over north Baluchistan and adjoining Afghanistan on the 2nd. It moved northeastwards across the extreme north of the country on the 3rd. It induced a well marked trough of low over northwest Rajasthan and adjoining West Pakistan on the morning of 3rd. The induced low shifted slightly northwards and lay over the Punjab (P) and deepened further by the morning of 4th. A feeble trough of low also developed further to the south over southeast Rajasthan and neighbourhood on the 4th. The well marked trough over the Punjabs moved away northeastwards across Himachal Pradesh and Punjab-Kumaon Hills and the feeble trough became unimportant by the morning of 5th.

Under the influence of the above systems rain or snow had been wideapread in Jammu and Kashmir, Himachal Pradesh and the Punjab-Kumaon hills on the 4th and 5th and local in these areas on the 3rd. Rainfall was fairly widespread in the plains of the Punjab on 4th and 5th, in east Uttar Pradesh and plains of NW Uttar Pradesh on the 5th and scattered in Rajasthan and plains of Uttar Pradesh on the 4th. Even though the rainfall reported from the observing stations was only moderate or light, it is seen from the press reports that some parts of Kashmir valley, Himachal Pradesh and the Punjab hills experienced heavy snowfalls, severe hail storms and continuous bad weather on the 3rd and 4th.

Vehicular traffic was completely disrupted in Jammu and Kashmir, Himachal Pradesh and the Punjab-Kumaon hills. The heavy snow falls set off avalanches one of which over-ran the construction works of the Banihal tunnel killing 11 workers. Communications with all the principal cities and towns in the area like Srinagar, Jammu, Simla and Nainital were cut off due to heavy snow falls on the roads. Air Services to Srinagar were completely suspended on the 4th and 5th.

In the wake of the western disturbance cold air swept over the entire northwest India resulting in a marked fall both in minimum and maximum temperatures. Even though the minimum temperatures did not reach much below the normals, the marked fall of temperature in the hills caused great hardship to the people and deaths due to cold spell were reported from some of these areas.

As the skies cleared up rapidly on the 5th, thick fog occurred locally in Rajasthan, the Punjab and Uttar Pradesh on the 5th and in Punjab-Kumaon hills, south Uttar Pradesh and adjoining areas on the 6th.

6. Western disturbance during the period 28 March to 2 April :

This disturbance lay over Afghanistan on the 28th. It moved slowly eastwards and moved across Kashmir on the 29th. It induced a trough of low extending from Sind to west Uttar Pradesh on the morning of 29th. The induced trough became more marked and lay over east Rajasthan, southwest Uttar Pradeah and northeast Madhya Pradesh on the evening of 29th. Thereafter, it moved more or less in a eastsoutheasterly direction and lay over northwest Orissa and neighbourhood on the 1st of April. It became less marked by the morning of 2nd. Under influence of this system rainfall was fairly widespread in Himachal Pradesh and Punjab (I) on 31st March and 1st April. Local rainfall occurred in Jammu and Kashmir from 29th March to 1st April, in west Rajasthan and west Uttar Pradesh on 30th March. According to newspaper reports, a severe duststorm swept over Delhi on 29th and was responsible for collapse of many houses, and damage to property. The maximum wind speed attained during the duststorm was 120 kms per hour (75 mph).

III. LOCAL STORMS 1959.

Of the local storms reported in newspapers, the following are noteworthy.

S. No.	Place	Date and time	Classification of storm	Loss of human life	Remarks
1	2	3	4	5	6
1.	Ujjain	19th January	Hailstorm		A fierce hailstorm lashed Ujjain for more than half an hour. It was reported that some of the hailstones weighed as much as a quarter Kg. Standing Rabi crops were damaged by hail stones and rain.
2.	Garoth (Mandasaur dist)	22nd January	Hailstorm	2	Two persons and a large number of cattle and birds have died as a result of falling hail stones. Crops were completely damaged in some areas.
3.	Azamgarh district	28th January	Hailstorm		259 villages in the district were affected, six of them suffered a total loss of crops.

1	2	3	4	5	6
4.	Jullundur	28th January	Hailstorm		Standing crop of wheat and gram was badly damaged in Dosanjhakalan virk and six other villages near Phagwara as a result of a severe hailstorm and heavy rainfall.
5.	Amritsar	28th January	Thunderstorm and rain		The city had three hours of heavy rainfall from heavy cloud burst after the thunder. All the vehicular and pedestrian traffic was held up for three hours. Low lying areas were flooded. Standing crops of wheat and gram were affected.
6.	Simla	28th January (afternoon)	Blizzard squall		Simla and adjoining hilly tracts were hit by blizzard in the afternoon lashing over 50 minutes. Thick flakes of snow were accompanied by squally winds.
7.	Patna	29th January)	Thunderstorm		A very strong easterly wind was blowing almost the whole day. There were intermittent thundershowers. Low lying areas were waterlogged and there were frequent power failures.
8.	Roorkee	27th March	Hailstorm		209 villages were adversely affected by hailstorm in Roorkee tahsil. Crops in nearly 70 villages totally damaged. Thousands of trees have been uprooted Rabi crop was also damaged. One man was injured by lightning.
9.	Bara Banki	28th March	Hailstorm		Rabi crop in 60 villages in Nawabganj tahsil was damaged.
10.	Delhi	29th March (evening)	Thunderstorm		The thunderstorm was accompanied by duststorm. Maximum wind speed reached was 75 mph. Roofs of about 100 tenements were blown away. Electric poles were broken and power supply was cut off in Purana Quila area for few hours.
11.	Ernakulam	4th April	Duststorm		A 20 mile an hour duststorm swept Alleppey-Cochin coastal belt on Saturday night uprooting number of coconut palms. Falling trees snapped over-head telegraph lines.

1	2	3	4	5	6
12.	Ahmedabad	18th April (night)	Gale	1	A fifty mile an hour gale lashed the city and suburbs at night. A large number of hutment dwellers in and around city were rendered homeless. More than a dozen persons were injured by falling trees, flying tiles, corrugated iron sheets and live snapped cables.
13.	Tirunelv-elli	19th April (evening)	Thunderstorm		Two and a half inches of rain fell in the city and suburbs in two hours in the evening. It was accompanied by thunder and lightning. Six persons became unconscious by the bolt of lightning.
14.	Nowgong (Assam)	19th May	Gale		A very strong wind uprooted a large number of trees. 30 houses including a factory of tea estate were levelled to ground. Thousands of houses suffered heavy damage. Power supply was cut off by fallen trees.
15.	Calcutta	21st May (evening)	Thundersquall	1	61 mph thundersquall lashed Calcutta city in the evening for half an hour. 50 persons were injured by falling trees. One person was electrocuted when he came in contact with live power cable snapped by falling tree. Thatched huts were blown away.
16.	Shrirampur (Ahmednagar district)	22nd May (evening)	Thunderstorm	3	60 persons were injured by tin roofs blown off the huts. Traffic in area disrupted and heaped fodder was blown away by strong wind.
17.	Delhi	27th May	Hailstorm		A viscount aircraft encountered a heavy hailstorm 150 miles west of Delhi. Windscreen of the plane was smashed and nose and wings were slightly damaged. Pilot was also injured.
18.	Ambala	27th May (evening)	Thunderstorm		60 mph dust laden wind paralysed the city life. Full fury of storm lasted for 25 minutes. It was followed by showers which brought down the temperature by 17°F. Telephone and telegraph communication broke down. Power supply was also cut off for few hours.

1	2	3	4	5	6
19.	Nainital	27th May (night)	Hailstorm		Violent hailstorm lashed Nainital at night. Hailstorm was followed by showers. Telecommunications were disrupted and power supply cut off for several hours. Several trees were uprooted and roofs blown away.
20.	Jaipur	31st May (evening)	Thunderstorm	6	Many houses collapsed because of heavy downpour. Power transmission lines were cut off. Six persons were killed by falling houses.
21.	Rampur	8th June	Thunderstorm	4	Four persons were killed and 15 injured when lightning struck village market. One big tree was reduced to ases.
22.	Thana	23rd June	Thunderstorm	1	A girl was killed by lightning. A cattle shed was set ablaze by lightning killing half a dozen cattle heads.
23.	Ahmedabad	24 June (evening)	Squall		16 persons were injured when a squall of 68 mph struck the suburbs of Ahmedabad. Communication and power lines were broken. Roofs of several houses were blown away.
24.	Delhi	26th June (afternoon)	Rainsquall	1	50 mph storm caused the death of one man through electrocution. Low lying areas were flooded and rail communication was disrupted. Shed of steel factory was wrecked by heavy rain and 20 workmen were injured.
25.	Ambala	28 June (afternoon)	Thunderstorm		74 mph storm hit Ambala in the afternoon for about 35 minutes uprooting trees and disrupting power supply and telecommunication systems. Sharp-showers brought down the temperature considerably.
26.	Delhi	27th September (afternoon)	Thunderstorm		A 30 miles per hour thunderstorm swept through the city. It uprooted a number of trees which snapped overhead power lines abd brought about a power breakdown.

1	2	3	4	5	6
27.	Delhi	1st October (morning)	Duststorm		Local and trunk telephones were interrupted by 41 mph duststorm and light showers. Air services were delayed. Roofs of several temporary structures were blown away.
28.	Baranagore	10th October	Thundersquall		Wind reaching 42 mph tore off large part of corrugated tin roof housing a refugee school and three other schools in Baranagore (suburb of Calcutta). It also severely damaged the school furniture and walls of the building.
29.	Surat	11 October (evening)	Gale	3	Three passengers were drowned when the ferry carrying them capsized in gale 12 miles from Surat.
30.	Madras	23 October (morning)	Thunderstorm	1	A woman was killed by a bolt of lightning. The lightning was accompanied by a short but very heavy spell of rain which flooded a large area.
31.	Bareilly	6th November (evening)	Thunderstorm	3	7 persons were injured. Hundreds of trees were uprooted, roof tops were blown off, power supply was cut off and telephones were put out of order. Road transport was also affected.
32.	Chandigarh	6th November (afternoon)	Severe hailstorm		A severe hailstorm accompanied by a sharp shower lashed Chandigarh and surrounding sub-mountain areas in the afternoon. A large number of birds were killed by the hailstones. The pedestrian traffic came to a standstill for the duration of storm.
33.	Bilasa Tahsil Jodhpur	14th November	Hailstorm		Bajra and other crops were completely destroyed by hailstorm. Many trees uprooted and hundreds of birds killed by falling hailstones.

IV. WINDS OF FORCE NINE OR MORE IN INDIAN SEAS

Excluding dates of storms and depressions, a description of which has been given above, winds of force 9 or more were recorded on ships in the Indian Seas during the year 1959 on the following occasions :

Month and date	Name of the ship	Approximate position	
		Latitude °N	Longitude °E
23 June	Amra	6.3	58.3
27 June	South Africa Star	8.8	56.3
27 June	South Africa Star	9.0	55.2
1 July	Oldkerk	12.2	56.6
2 July	Kaderbaksh	14.5	72.9
2 July	Bharatratna	17.8	72.5
3 July	Indian Trader	10.0	66.0
3 July	Strathaird	17.3	62.6
3 July	Strathaird	16.9	61.0
3 July	Indian Trader	10.0	64.0
4 July	Indian Trader	10.1	62.0
4 July	Indian Trader	10.3	59.2
5 July	Exchequer	14.6	67.5
5 July	Indian Trader	10.6	57.1
18 July	Bhatjan	9.8	53.5
19 July	Romantic	10.6	53.1
20 July	Bunosaires Maru	9.5	65.3

TRACKS OF STORMS AND DEPRESSIONS

(IN THE INDIAN SEAS)

1959

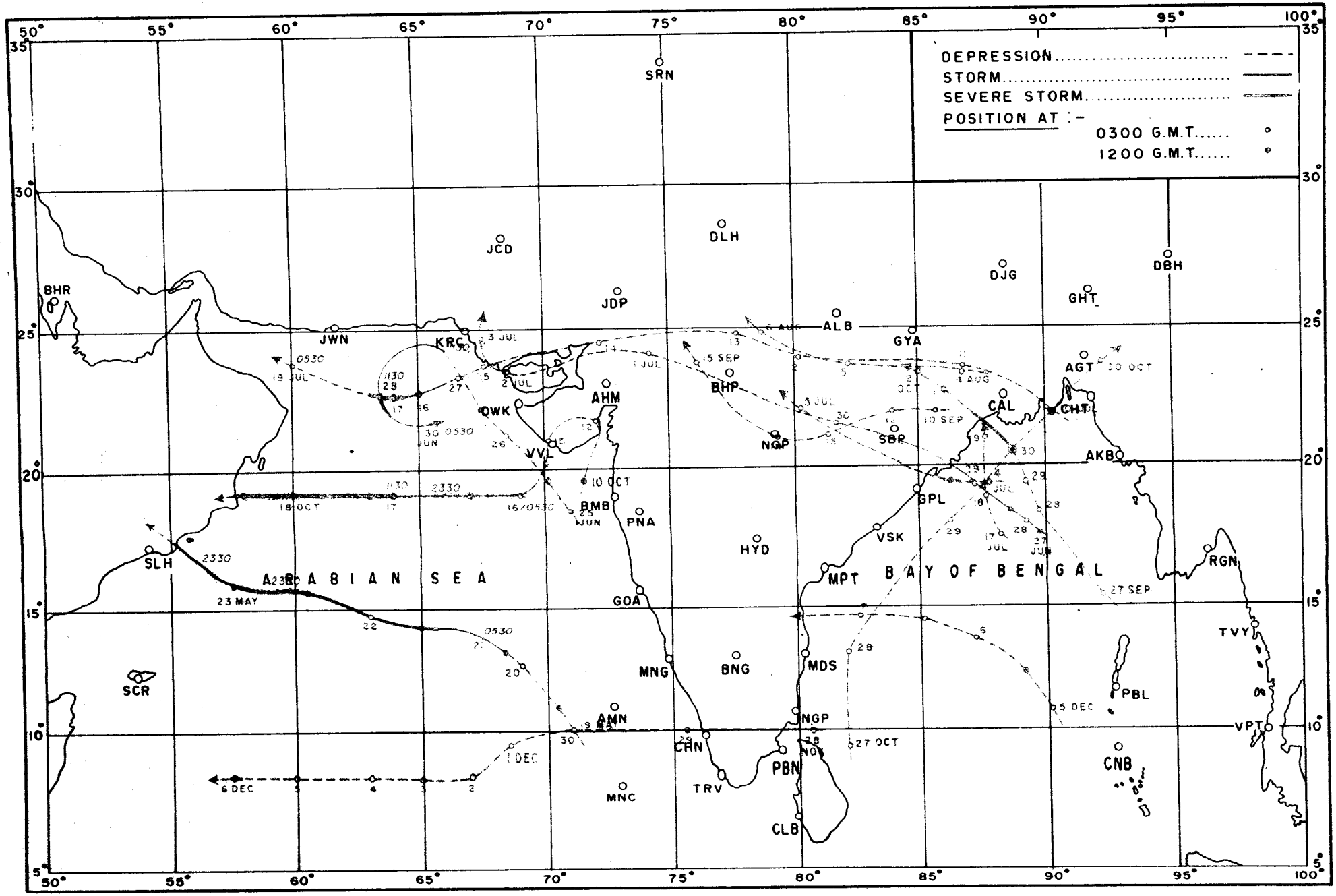

FIG. 1